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AMERICAN SUSPENDED OPEN HEARTH ROOF

OPEN HEAVEN BOOK
AMERICAN SUSPENDED

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Patents issued and pending in U. S. and foreign countries.

BULLETIN NO. 105

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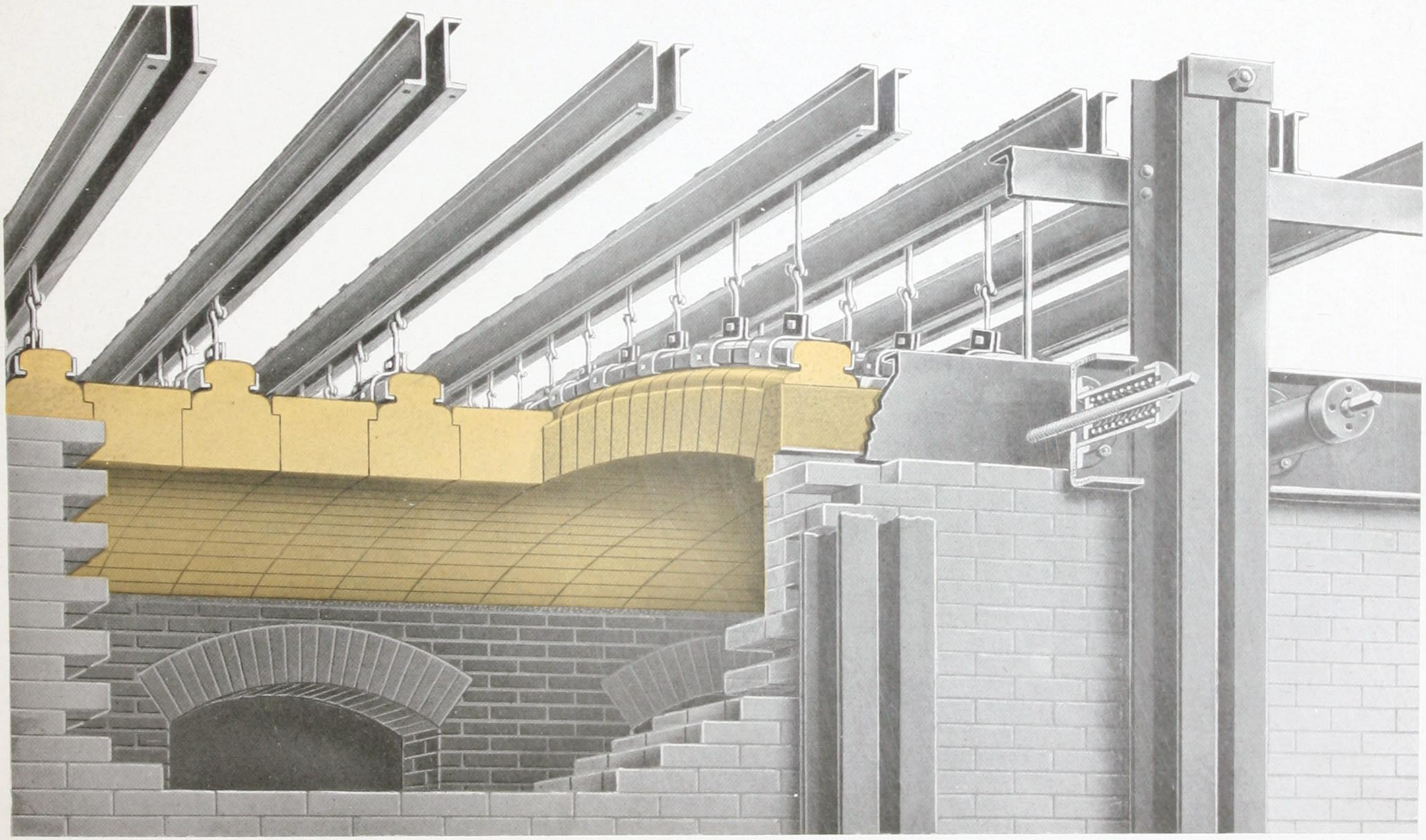


AMERICAN SUSPENDED OPEN HEARTH ROOF

Need for a Suspended Roof

Open hearth furnace life and production profits are limited primarily by the life of the roof.

The sprung roof in general use imposes on the refractories stresses and strains which are chiefly responsible for the indefinite life obtained. The efficient use of available refractories with longer roof life is possible only by radical change in roof design and method of support.

In the sprung roof the length of life is vitally influenced by the ability of the roof refractories to carry a load when close to the softening point. This is due to the custom of driving the furnace at a temperature close to the point where the roof brick soften and drip. The furnace is run until the roof is so reduced in thickness that it will not support its own weight.

All the weight of the sprung roof is carried on the relatively small area of the skews. The skews and every brick in the roof proper must carry a varying proportion of this weight and in addition they are subjected to excessive expansion pressures at high temperatures and great and widely varying stresses due to temperature changes in the furnace.

Unrelieved expansion pressure and consequent roof distortion are almost inevitable in a sprung silica roof and are responsible for pinching and disintegration of the refractories, resulting in reduction of roof life and tonnage of steel produced.

Loosening of the tie rods affords partial relief, but requires a nicety of judgment which may fail at a crucial time. With buckling, both roof weight and expansion pressure are concentrated on the lower portion of the brick which have been reduced in load carrying ability by high temperatures. Flattened roofs mean open joints, more rapid attack by the flame and there is danger of collapse with the loss of a heat and furnace time during repair.

When sprung roofs become thin, it is frequently a question whether to continue to run the furnace with possible loss of the roof and a heat, or to shut down the furnace with loss of production when badly needed.

The necessity for an improved type of roof, without the disadvantages of a sprung roof has long been realized, as the life of the roof limits the life of the furnace and the steel produced. Such an improvement has at last been realized in the American Suspended Open Hearth Roof illustrated and described herein. It is offered for general application after nearly two years' service under the most severe conditions.

General Description and Advantages of the American Suspended Open Hearth Roof

The American Suspended Roof as applied to open hearth furnaces, and as a rule to other types of melting furnaces, is of the radial type. It can therefore be applied to existing Open Hearth furnaces in place of a sprung roof without change in furnace lines which would affect furnace conditions or operation.

It retains the good features of the sprung roof. First: The radiant heat is reflected toward the center of the furnace where the charge is deepest and away from the front and back wall. Second: Loss of brick through cracking and spalling is reduced by the use of wedge shaped brick held in close contact. This is of particular importance due to the characteristics of silica refractories.

In the American Suspended Roof all the weight of the roof is carried *vertically*.

The silica tile are hung *from their cool side* by *exterior supporting means* which are adequately protected from furnace temperatures. The load carrying requirements of the tile are therefore reduced to their own weight.

There is no possibility of buckling of the roof as expansion is *automatically* relieved, yet sufficient pressure is maintained to insure permanent brick to brick contact and tight joints.

The expansion travel follows the contour of the roof.

There is no increase in the rise of the roof when the furnace is heated up but the span increases by the amount of the brick expansion.

Distortion is impossible.

Pinching and disintegration from unrelieved pressure do not occur.

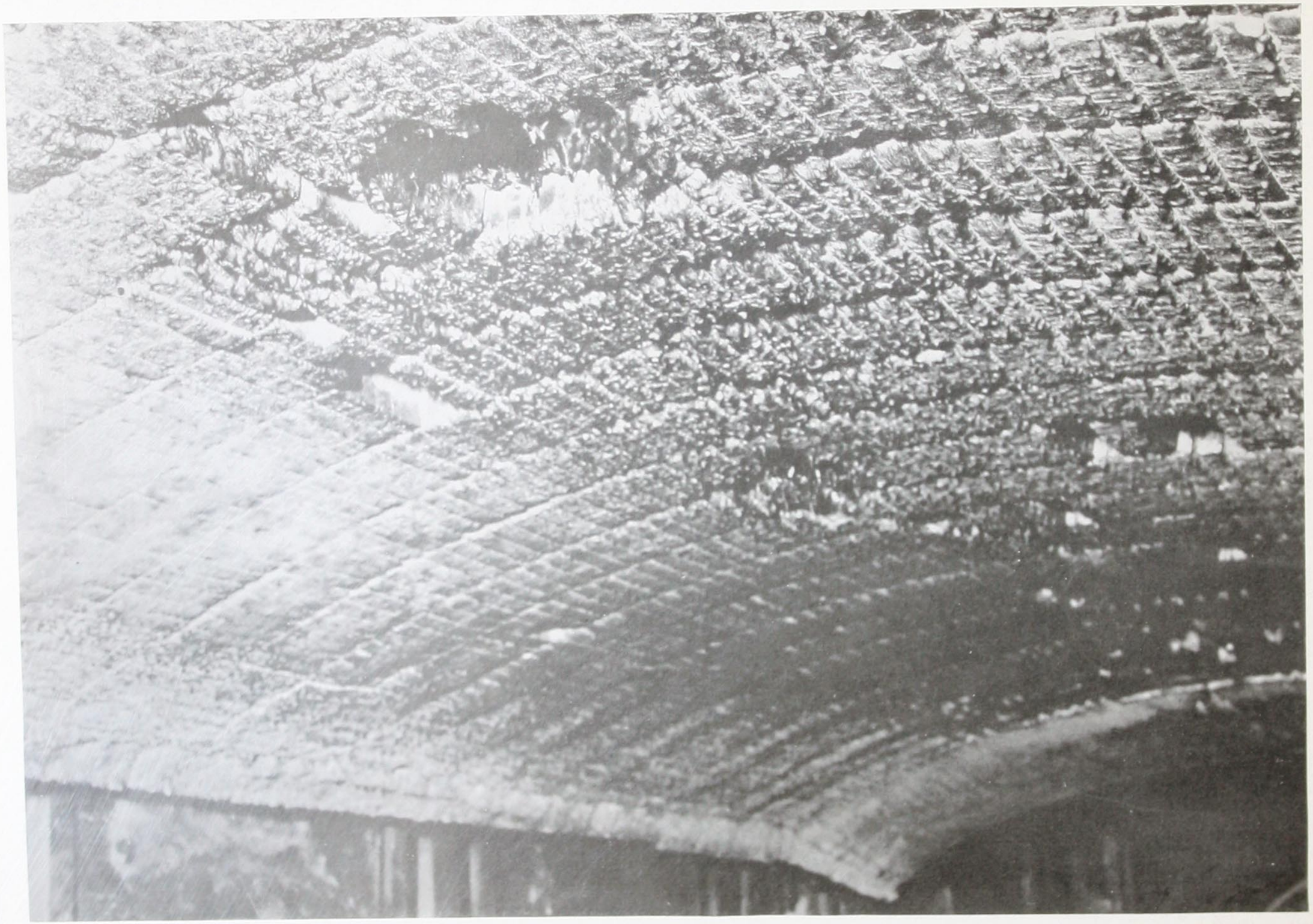
Even though the roof wears very thin, there is no danger of sudden collapse of a ring or section. This permits the extension of a campaign beyond the usual period to meet peak production requirements.

The moderate pressure exerted at the skew line limits flame action to one exposed surface of the roof brick by maintaining close brick to brick contact.

Due to the characteristics of silica refractories, which are universally used in open hearth roofs, and to temperature variations, some spalling or cracking is inevitable and localized burning will occur from impinging flame. Where a hole occurs through spalling or burning, the excessive pressures in the sprung roof tend to break off the exposed portions of the surrounding brick. In the American Suspended Roof destruction of the adjacent brick is less rapid as the thin section is carrying only its own weight and is relieved of excessive pressures.

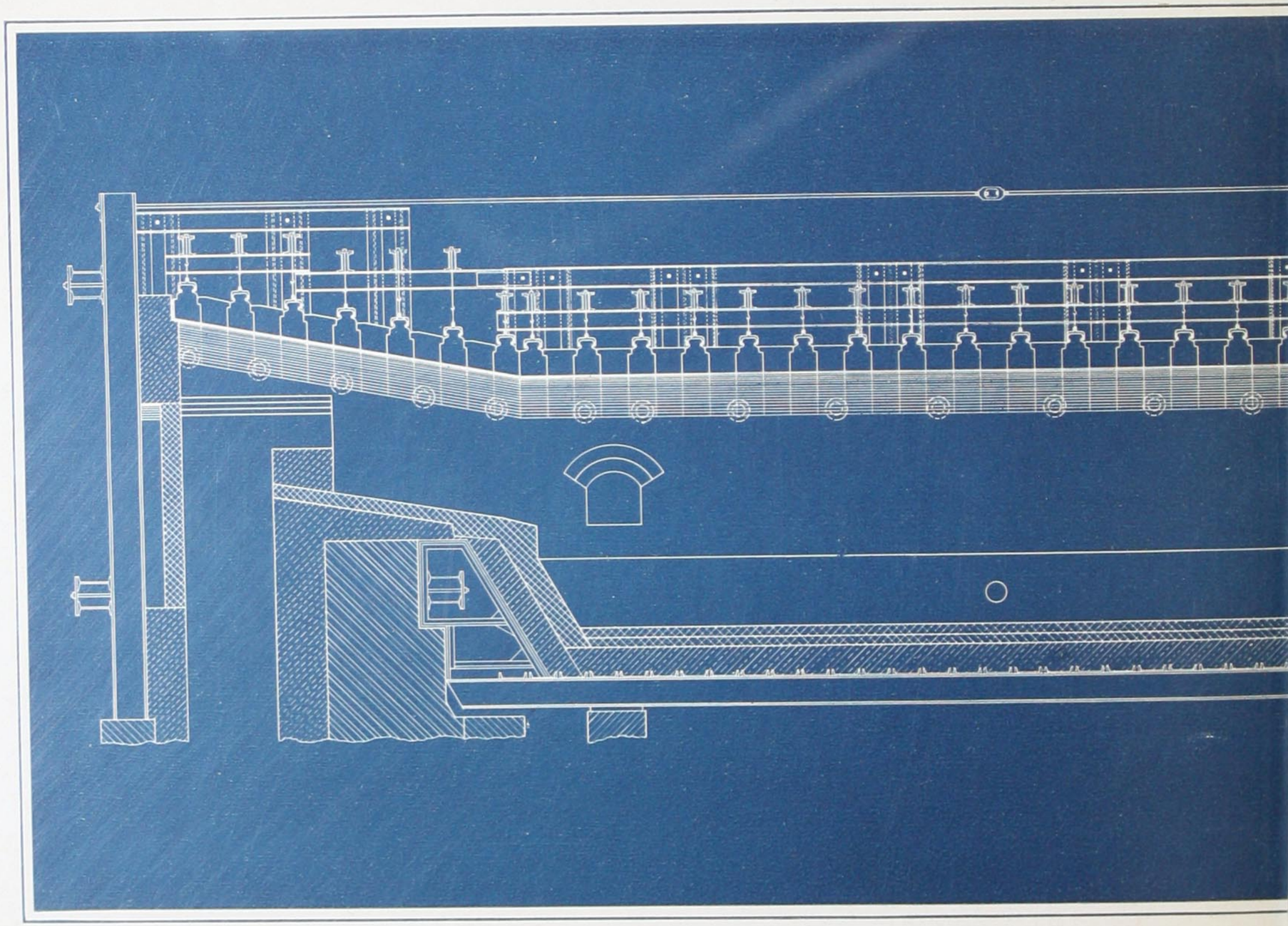
A thin sprung roof nearing the end of a campaign is a menace to the safety of the men operating the furnace. With the American Suspended Roof the operators are protected against roof collapse. Inspection or repair can be made with safety.

All the advantages of the American Suspended Roof tend toward greatly increased roof life and greater tonnage produced in a given period of time.

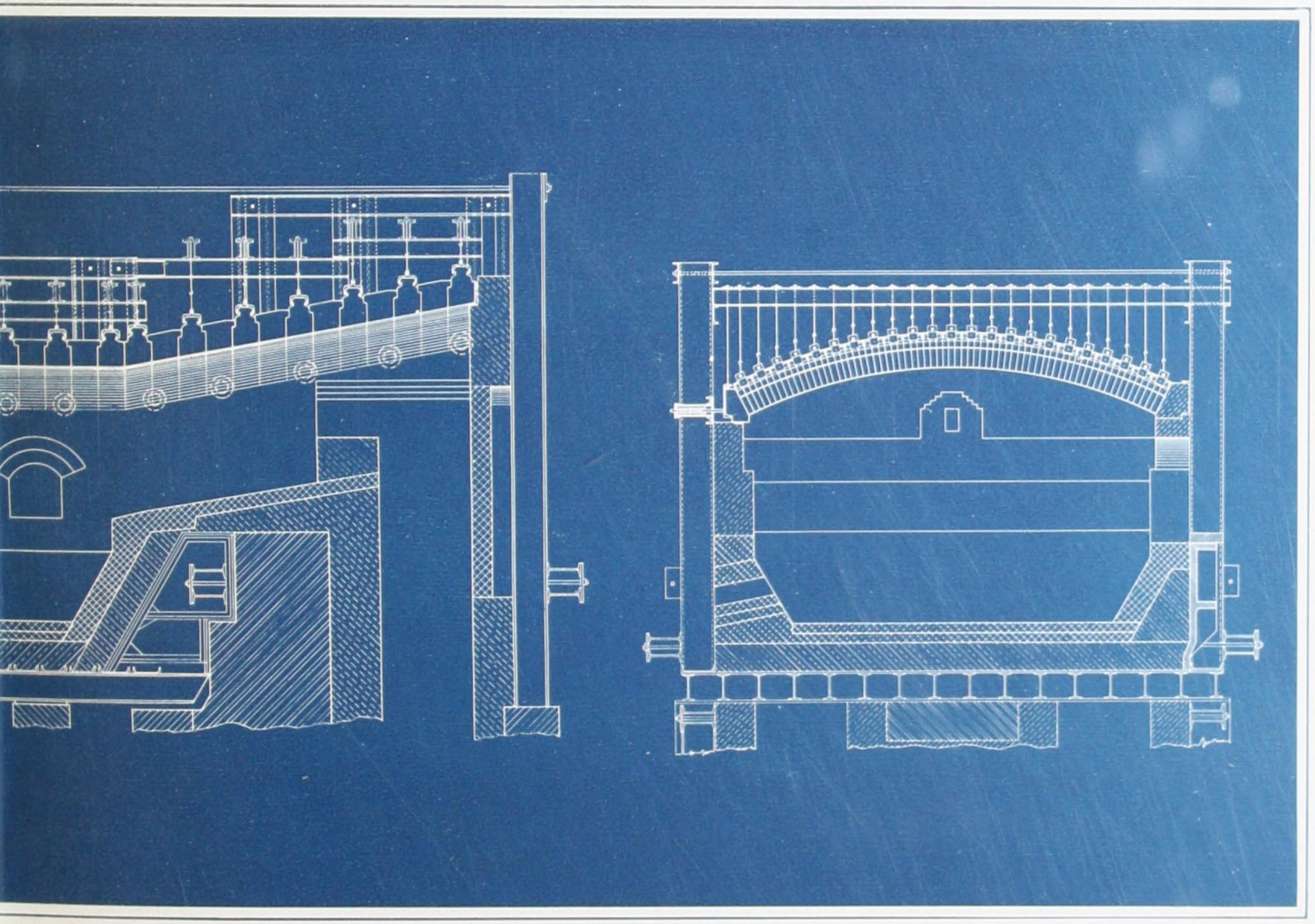


Application of the American Suspended Roof to 70 ton Basic Open Hearth furnace producing low carbon steel and ingot iron—all cold charge. Condition before repair after campaign of 168 heats. Note repairs made as shown by photograph on opposite page.

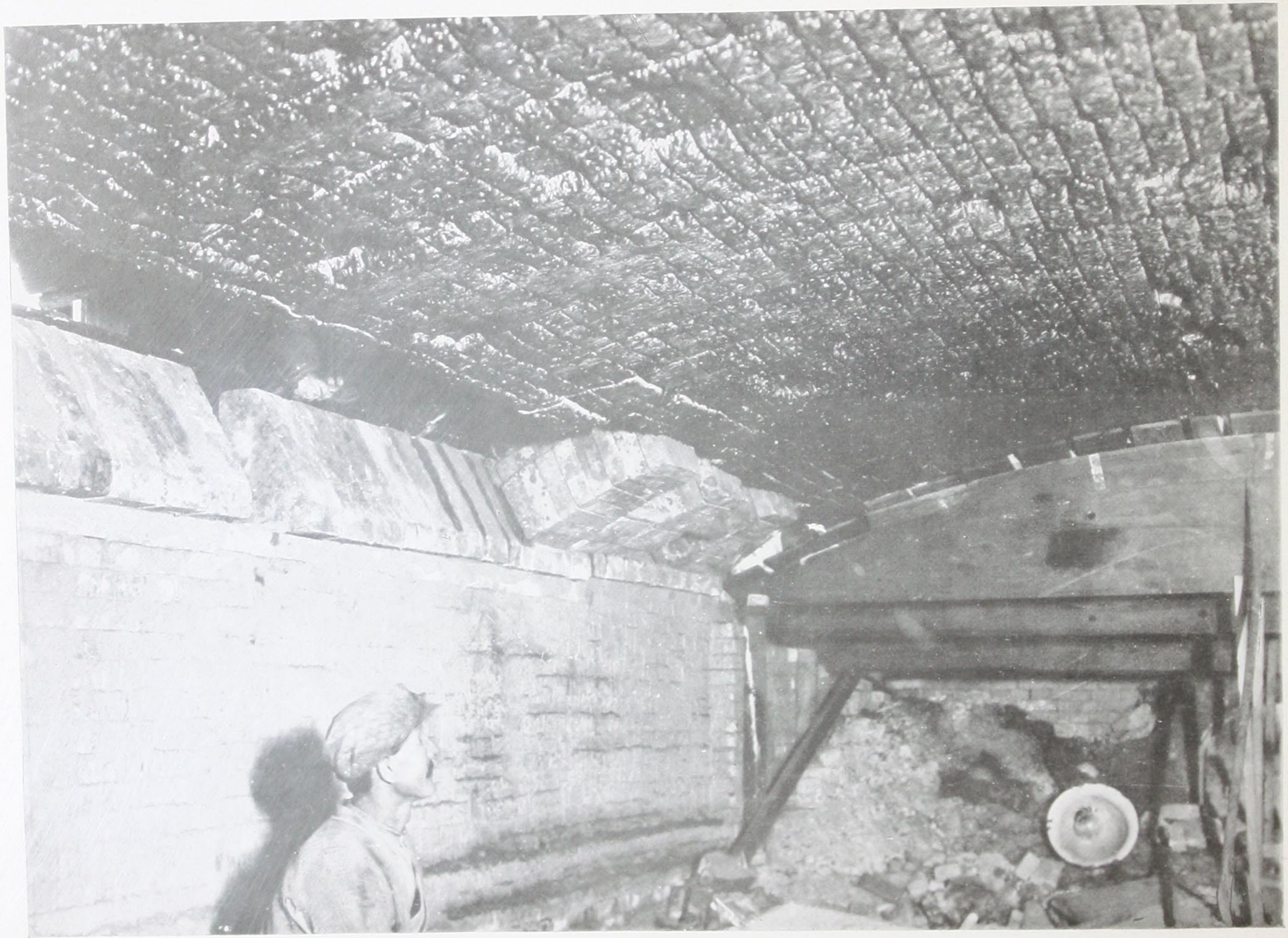
Repairs made, and this American Suspended Roof is ready for another full campaign. Three campaigns with two partial repairs as shown resulted in 428 heats from this roof as against an average of less than 200 heats with the sprung roof on this furnace during the preceding six year period.



American Suspended Roof for application to Oil, Cok



ven Gas, Tar or Combination-fired Open Hearth furnaces.



Excessive cutting over the back wall of this Basic Open Hearth furnace occurred during the first campaign of 197 heats. The skews and eighteen to twenty-four inches of the American Suspended Roof for the entire hearth length were easily renewed. One hundred sixty eight heats were run during a second campaign after this roof repair. The total roof life of 365 heats was almost double the previous average with the sprung roof.

Repair over the back wall completed. An average of three inches of the roof is burned away as indicated by offset where green brick end. Although exposed on two sides, not one of these brick cracked or broke off during the second campaign as they are supported vertically, can expand freely and are relieved from excessive pressures.

Details of Design — American Suspended Open Hearth Roof

American Suspended Roof Brick

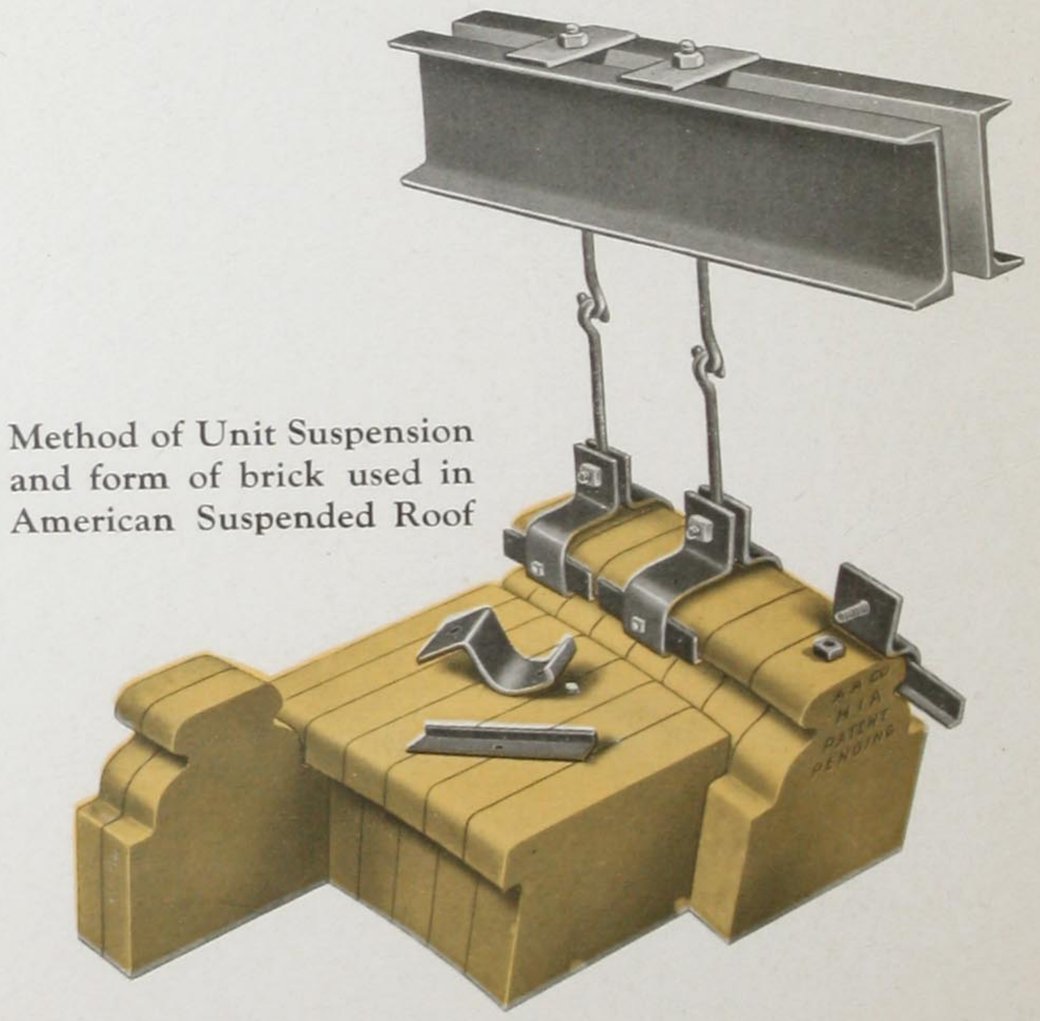
In the American Suspended Roof, two silica shapes are used—a hung and a filler. They are relatively small in size and offer no unusual difficulty in manufacture.

The hung brick for a 12 in. effective depth roof is approximately 15¼ x 12 x 3 in., tapered to suit the required radius. It has a substantial extended head from which it is suspended.

The filler brick for a 12 in. effective depth roof measures approximately 12 x 12 x 3 in., also tapered. It has two extended lugs on the upper end which rest upon corresponding shoulders of the hung brick.

The hung brick and filler brick alternate in courses across the furnace with every cross joint a by-passed joint. This by-passed joint permits provision for longitudinal expansion of the roof by shingling the cross joints, and reduces the heat losses and the detrimental effect on the roof brick which result from straight open joints.

As a rule, the standard skew blocks for the sprung roof can be used in connection with the American Suspended Roof.



Method of Unit Suspension and form of brick used in American Suspended Roof

Suspension Means

The entire weight of the American Suspended Roof is carried vertically from channels spanning the furnace. These channels rest at each end upon angles attached to the vertical buckstays.

As illustrated on page 12, each pair of angles and clips engage and support three hung brick. Hook bolts carry each unit of three brick from the overhead supports.

It will be noted that all supporting means are outside of the brick and readily lose their heat by radiation. The suspension means are therefore virtually permanent.

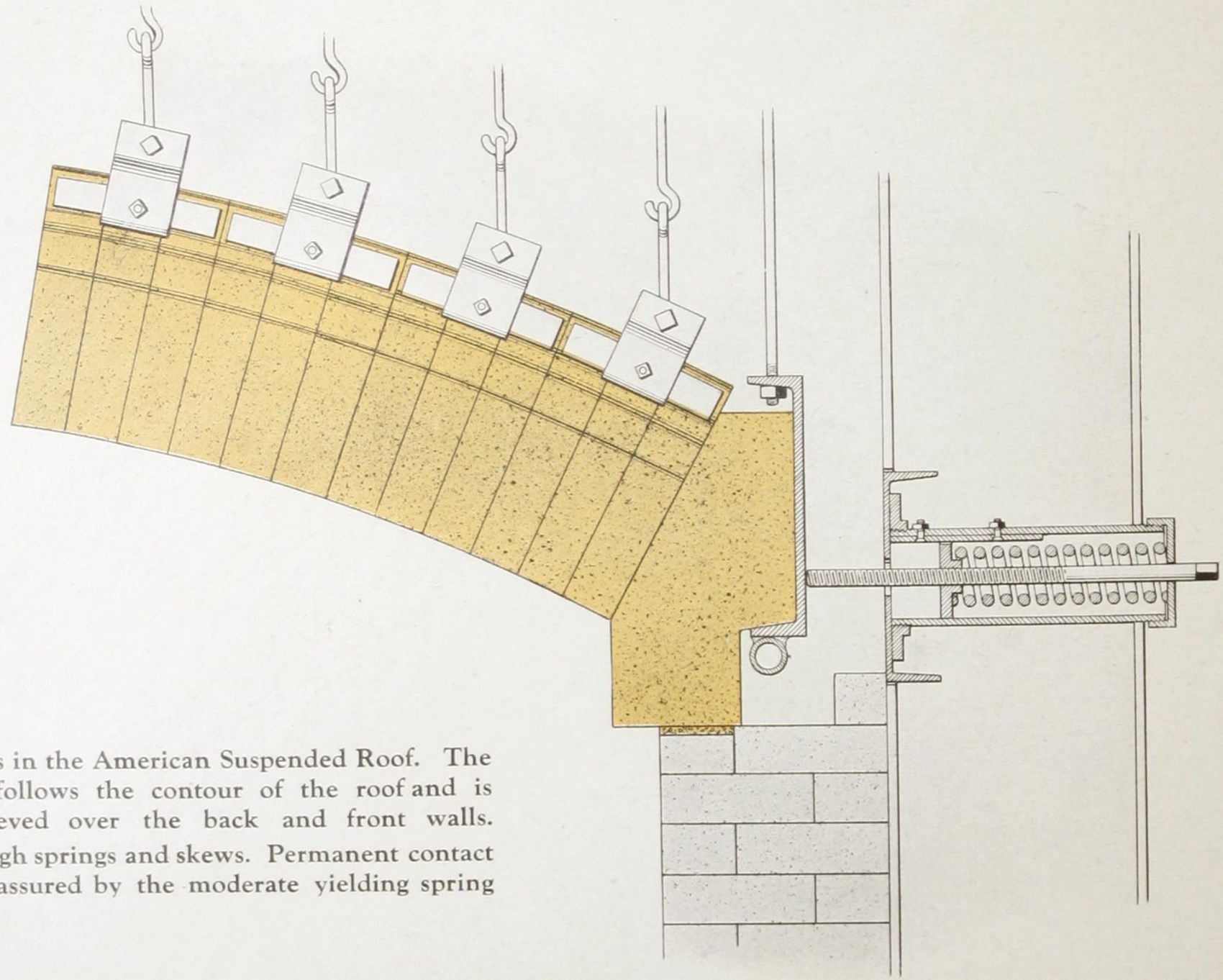
Provision for Expansion and Contraction

Moderate lateral pressure exerted at the skew line automatically relieves the roof brick from injurious expansion pressure and maintains tight joints on contraction. This is accomplished by a series of compression springs encased in ventilated housings and placed between the buckstays as illustrated on page 14.

The spring pressure is exerted horizontally through spring rods against suspended skew channels which in turn support the skew blocks.

The springs are set with an initial pressure just sufficient to maintain the roof brick to radial lines and in close contact. While adjustment may be made in the springs to vary the initial pressure when application is made to furnaces of varying widths, no subsequent spring adjustment is necessary during the heating up and cooling off of the furnace. Actual operation has shown that the span of an American Suspended Roof over a furnace 14 ft. between walls increases an average of 1¾ in. during the heating up period as measured by the spring rod travel. There is no increase in the rise of the roof.

It is desirable to use the floating skews and spring sets over both front and back walls to permit expansion in both directions. Where conditions prohibit the use of springs on both sides, the usual type of fixed skew can be used over the front wall and all expansion taken care of over the back wall.



No buckling occurs in the American Suspended Roof. The expansion travel follows the contour of the roof and is automatically relieved over the back and front walls. Note section through springs and skews. Permanent contact between brick is assured by the moderate yielding spring pressure.

Applications — American Suspended Arches

METALLURGY

American Suspended Arches, either of the Flat or Radial type have been adapted for use on:

Annealing Furnaces
Air Furnaces
Billet Heating Furnaces
Copper Refining Furnaces
Continuous Annealing Furnaces
Continuous Heating Furnaces
Core Ovens
Car Type Annealing Furnaces
Forge Furnaces
Electric Furnaces, Rectangular Type
Intermittent Heating Furnaces
Malleable Melting Furnaces
Malleable Annealing Ovens
Open Hearth Furnaces
Periodic Annealing Furnaces
Pipe Heating Furnaces
Pit Annealers
Plate Heating Furnaces
Rail Heating Furnaces
Reverberatory Furnaces
Soaking Pits
Tube Heating Furnaces
Welding Furnaces
Wire Heating Furnaces

MISCELLANEOUS

Cement Kiln Dust Chambers
Cracking Coils
Dryers
Flues, Waste Heat
Glass Melting Furnaces
Glass Annealing Ovens
Incinerators
Oil Stills
Tar Stills
Zinc Sheet Mill Melting Pot Furnaces

BOILER FURNACES

Many satisfactory applications of the American Suspended Arch have been made in connection with varying firing equipment and the various makes of boilers as follows:

Chain Grate Stokers . .	Coxe, B & W, Green, Harrington, Illinois.
Overfeed Stokers	Detroit, Model, Murphy.
Underfeed Stokers . . .	Frederick, Jones, Riley, Taylor, Westinghouse.
Pulverized Coal Equipment	Aero, Erie City, Fuller, Lopulco and Simplex Systems.
Miscellaneous	Bagasse, Blast Furnace Gas, Combination Fired, Refuse Burning Boilers.
Boilers	Badenhausen, B & W, Brownell, Bigelow-Hornsby, Connelly, Edgemoor, Erie City, Heine, Keeler, Kidwell, McNaull, Murray, Oil City, Page, Rust, Springfield, Stirling, Toledo-Flanner, Union, Vogt, Walsh & Wiedner, Wickes.

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